Forest Sciences

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Alleviating Compaction of Medium-Textured Soils with the Winged Subsoiler

Research Issue Groups:

- Forest Biology
- Forest Growth
- Soils
- Wildlife Habitat
- Silviculture
- Ecosystem Inventory and Classification
- Biodiversity
- Ecosystem Management
- Hydrology
- Geomorphology
- Extension

Introduction

The successful rehabilitation of landings largely depends on the alleviation of soil compaction. The winged subsoiler has been used to decompact landings in the past, and experience has shown consistently good results for coarse-textured sites but more variable success on medium- and fine-textured sites. An opportunity to examine this problem further arose when Pacific Inland Resources (PIR) initiated the reclamation of over 60 landings from the Telkwa River chart area during August of 1995. This extension note will explain:

1) how the subsoiler works;
2) soil properties that lead to good subsoiling results;
3) the resulting changes in soil physical properties; and,
4) the amount of landing area that has been effectively decompacted.

Decompacting soil with the winged subsoiler

The winged subsoiler has three hydraulic shanks mounted with wings at the ends, which pull the shanks down into the soil (self-drafting) against the resistance of the compact soil. When adjusted properly, the wings should lift the soil slightly, causing the soil to shatter sideways. In this way the compaction is alleviated without mixing the soil, like other tillage equipment might. In addition, the soil *between* the shanks is shattered, rather than just the soil around the shank. This means that the soil profile can be shattered in one pass, rather than repeated or criss-cross passes like other equipment might require.

The wings on the subsoiler can be adjusted to match soil conditions, particularly if the soil is dry, high in clay content, or extremely dense. The operators of the subsoiler should be aware of the possible different settings. The trench created by the shanks should be narrow, and the soil should **not** be pulled up into furrows. Furrows indicate that the subsoiler is not penetrating deep enough, so that the soil is pulled up rather than shattered.

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Soil properties related to subsoiler success

Often landings with medium-textured soils have been poorly decompacted, due either to improper use of the winged subsoiler or to difficult soil conditions. The reclamation work by PIR was monitored to determine whether soil conditions on these landings were too extreme for the subsoiler to work properly. Subsoiler effectiveness was monitored by rating the ripping as either 'high', 'medium', or 'low', depending on how well the soil had shattered. Regression analysis of depth of ripping showed that the subsoiler worked better with increasing soil moisture and clay content:

Depth = -12.1 + 1.64 (% moist) + 0.86 (%clay)
r^2=0.41, prob>F=0.0002,

Low soil moisture creates sufficient soil strength to reduce the depth of soil the subsoiler can penetrate. Intermediate soil moisture creates a more friable and workable soil, which allows the subsoiler to shatter to greater depths. Soil that is too wet, however, slices deeply but does not shatter as well.

The clay content of the landings ranged from 10 to 28%, which includes soils of sandy loam and loam texture. High clay content increases soil strength, which you might think would reduce the effectiveness of the subsoiler, but instead the increasing clay content increases the degree of shatter. The platy structure and denseness of the clay appears to transfer the energy of the subsoiler better between the furrows than does sand or silt.

Soil moisture and clay content explained only 41% of the soil properties affecting subsoil shatter. A third factor, which was not measured, could be the initial bulk density of the soil. Much of the 'low' subsoiling success was found close to the haul road, where traffic was likely to have been the heaviest. Soils that were comparatively dry and heavily compacted had the poorest results.

Physical properties resulting from subsoiling

The three levels of subsoiler success, 'high', 'medium', or 'low', were measured on several landings to determine the average depth of shatter and bulk density of the soil profiles resulting from subsoiling (Table 1). When the subsoiler worked properly the soil compaction was effectively reduced. A bulk density of 1.19 g/cm³ for the 0-30 cm depth is comparable to what would be found in undisturbed soils (1.0-1.1 g/cm³). The overall depth of decompaction was 36 cm, which is a comparable rooting depth for many forest soils. However, the structure of the soil was still poor. Many of the soil peds were not true aggregates, where soil particles are held together with organic matter. Instead the soil was broken into lumps of solid soil particles (silt and clay), which are denser and probably less productive than true soil aggregates. It is important to recognize that the winged subsoiler cannot, on these loam subsoils, recreate structured, well-aggregated soil. The subsoiler can only loosen the soil enough to allow root growth deep into the soil profile. High amounts of roots and mycorrhizal fungi will help restore the soil conditions needed for productive tree growth. It is these biological processes that complete the rehabilitation of the soil.

Summary of subsoiling results and costs

Thirty of the sixty-five landings were visually assessed for subsoiler success. In this survey, 41% of the landing area was rated high, 32% medium and 27% low. The total area subsoiled was 26 ha, over 3 sites, which took approximately 8 days to complete. The contractor spent 1 day on the site adjusting the wing pattern of the subsoiler. For these sites, the average cost for subsoiling is $220 per landing or $550 per hectare.

Table 1. Physical properties of landings after subsoiling.

Subsoil success	n	Furrow depth (cm)	Shoulder depth (cm)	Mid-furrow (cm)	Overall depth (cm)	Bulk density 0-30 cm depth (g/cm³)
High	10	46	34	29	37	46
Medium	10	33	23	18	24	33
Low	13	17	14	11	14	17

Overall, 41% of the total landing area was decompacted well, with good depth and shatter across the profile. How can subsoiling effectiveness be improved on these sites? According to this research, the moisture content, clay content and perhaps bulk density affected the subsoiler effectiveness. The amount of clay and bulk density of the soil are fixed, but the moisture content can vary and rehabilitation work can be timed accordingly. For example, better conditions may occur in the spring, after snowmelt has recharged the soil with moisture. Winter landings are often saturated at first but continue to drain for a few years after being built. In this case it may be better to start rehabilitation work immediately during the winter, while the ground is frozen, or after two or three years have passed. There are no definite answers to this question - local experience and monitoring of conditions should guide decisions on the best time to subsoil.

Conclusions

- The winged subsoiler can shatter medium-textured soils well.
- The subsoiler has to be adjusted to match site conditions for optimum shatter.
  The landing area surrounding the haul road is often the most difficult to shatter and should be used to calibrate the subsoiler.
- Moisture content is one factor which can be accounted for in operations.
  Landings are often very dry by late summer. Other times which might be more favorable include early spring, late fall, or during the winter on frozen ground.

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